

# METHOD AND APPARATUS FOR SCAN OPERATION IN AN INTEGRATED VOICE AND DATA COMMUNICATION SYSTEM

## Field of the Invention

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The present invention relates generally to communication systems, and more particularly to a method and apparatus for providing scan mode operation in a communication system that supports both voice and data communications.

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## Background of the Invention

Wireless communication systems support and provide a wide variety of features and functions for their users. For example, conventional voice/data systems allow a subscriber/mobile station to monitor multiple communication channels provided by the fixed network equipment for traffic that is of concern to that mobile station. This is typically referred to as the mobile station being in "scan mode." Scan mode allows a mobile station to check a succession of radio channels on a periodic basis to determine if voice information is present, and then to remain on that channel to receive the voice information. At times, this means that the mobile station will arrive on the channel in mid-transmission.

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Transmitted voice, whether sent in analog or digital form, is designed to readily allow a late entry into the transmission through the periodic inclusion in the voice transmission of synchronization (sync) and destination ID information. The periodic inclusion of this information permits the mobile station to determine that the voice information is intended for that station, and allows the mobile station to receive the subsequently transmitted, although incomplete information.

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An enhanced form of scan mode is referred to as priority scan. In priority scan the user may designate certain channels, typically 1 or 2 channels, as priority channels. These channels are scanned more frequently, usually every other channel as the mobile station advances through its scan channels list. Moreover, if the mobile station is receiving a transmission on a non-priority channel, it will,

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the data packet being transmitted. The direct result is that the amount of information that can be carried on the channel is greatly reduced.

Thus, there is a need for a method and apparatus for permitting scan mode and priority scan with data reception in an integrated voice/data communication system without significantly degrading the information carrying capacity of the communication channel.

### Brief Description of the Drawings

FIG. 1 is an illustration of communication system adapted in accordance with the preferred embodiments of the invention.

FIG. 2 is a chart illustrating the operating states of a method for providing scan operation at a mobile station in accordance with a preferred embodiment of the invention.

FIG. 3 is a chart illustrating the operating states of a method for providing scan operation at a base station or data controller in accordance with a preferred embodiment of the invention.

FIG. 4 is a chart illustrating the operating states of a method for providing scan operation at a mobile station in accordance with an alternate preferred embodiment of the invention.

FIG. 5 is a chart illustrating the operating states of a method for providing scan operation at a base station or data controller in accordance with an alternate preferred embodiment of the invention.

FIG. 6 is an illustration of a data message in accordance with a preferred embodiment of the invention.

FIG. 7 is an illustration of a group of data messages in accordance with a preferred embodiment of the invention.

### Detailed Description of the Preferred Embodiments



station 12 is coupled to a radio network controller 20, which is further coupled to a data controller 22 and via a packet network, such as IP network 24, to a host computer 26. A first mobile station 28 and a second mobile station 30 operate in the coverage area of the communication system 10 and communicate with the base station 12 via radio signals generally illustrated as 32. The signals 32 are carried on a plurality of communication channels that may be provided by base station 12, or by base station 12 and additional base stations (not depicted), forming communication system 10. Either mobile station 28 or 30 may operate in a scan mode, wherein the mobile station scans from communication channel to communication channel. Furthermore, each mobile station 28 and 30 may receive data messages, such a data packets, while operating in the scan mode. The host computer 26 accepts data messages for transmission to either or both of mobile stations 28 and 30. A data message is carried via the IP network 24 to the data controller 22 where it is processed for delivery via the radio network controller 20 and base station 12 to the intended mobile station 28 or 30.

FIG. 2 illustrates a scan mode 100 of operating for either mobile station 28 or 30. To illustrate the invention, the following discussion refers to mobile station 28, although the discussion is equally applicable to mobile station 30. While in an idle state 102, mobile station 28 is on a particular channel and is not scanning. The mobile station 28 enters scan mode 104 by manual selection by the user of the mobile station 28. Before transitioning into the scan mode 104, the mobile station 28 transmits a message, such as an "I am in scan" message, to the fixed network equipment, i.e., base station 12 and data controller 22.

While in the scan mode 104 the mobile station 28 sequences through a predetermined list of channels in round robin fashion, checking for channel activity at each. If scan is deselected by the user, the mobile station 28 transmits a message, such as an "I am out of scan" message to the data controller 22 and returns to the idle state 102.

While in scan, if a data message is detected on a channel, the mobile station 28 transitions to the determine the data message type state 106. There are



type state 112 and the wait subscriber reply time state 114 several times before receiving its data packet.

The determine packet type state 112 has two possible outcomes. If the received data packet is a preamble list, then the mobile station 28 moves to the subscriber ID in preamble list decision state 108. If the data packet is not a preamble list, then if it is addressed to the mobile station 28, the mobile station 28 processes the data packet, sends an acknowledgement and moves to the wait subscriber's reply time state 114. The only difference between the determine packet type state 112 and the determined packet type state 106 is that a data packet not addressed to the mobile station 28 causes the mobile station to return to the wait subscriber's reply time state 114 and not return to scan mode 104. The purpose for the difference is that, in order for the subscriber to be in the determine packet type state 112, it must have first received a preamble list with its ID in it or a data packet addressed to it. As a result, the mobile station 28 is likely to receive a data packet on the channel and should remain on the channel as long as activity is present.

FIG. 3 illustrates a scan mode 200 of operating for the fixed network equipment, i.e., data controller 22. From an idle state 202 the data controller 22 receives a message from a mobile station, such as mobile station 28, and determines if the message indicates that the mobile station is in scan mode. If so, the data controller 22 sets at 212 an in-scan mode flag in a mobile database (not depicted) maintained within the data controller 22. The data controller 22 then continues with normal processing of the received message 208 and saves the received time value for a hang-time check 210. The hang-time check is associated with each mobile station in scan mode. A timer is reset after each packet acknowledgment is received from the mobile station, and will expire after a predetermined period of time. The duration of the timer is set to account for the reception of replies by the mobile station, and will expire following the predetermined period of time following the last outbound data packet for that mobile station. The timer accounts for the time the mobile station remains on the

channel in the absence of data traffic for that mobile station and is used in accordance with the invention to send subsequent data packets without a preamble.

5 If the message does not indicate that the mobile station 28 is entering scan mode 104, but instead indicates that it is out of scan mode, 206, then the scan flag in the mobile database is cleared at 214. The data controller 22 then continues with normal processing of the received message 208 and saves the received time value for the hang-time check 210.

10 When a mobile station is not in scan mode, then the data controller 22 has its channel location and may send data messages to it using without using a preamble. However, when one or more mobile stations are known to be in scan mode, the data controller 22 first sends a preamble for data messages intended for those mobile stations in scan mode. In accordance with the preferred  
15 embodiments of the invention, the preamble includes a preamble list that identifies the mobile station or mobile stations to which data messages are directed. Preferably, the preamble list will contain the identification of the next "X" mobile stations to receive data messages. The mobile stations will detect the preamble, analyze the preamble list, identify its corresponding identification and remain on the channel for a pending data message. Thus a separate preamble is  
20 not required for each data message because the data controller 22 now knows the mobiles are migrating to the acknowledged channel.

With reference to FIG. 6, a data message 600 includes a preamble portion 602 and a data packet 604. The preamble portion 602 is preferably a plurality of short confirmed message packets 606, each of which contains the preamble list.  
25 The duration of the preamble is configurable by the data controller 22 to be slightly longer than the time needed for the longest scanning mobile station to cycle through its list of scanned channels when all channels are vacant of traffic. The preamble may be addressed "all\_call", that is, its destination is to all mobile stations operating in scan mode in the communication system 10. The data packet



604 is the data packet intended for the mobile station identified first on the preamble list contained within the short confirmed message packets 606.

To reduce traffic due to the preamble transmission, in accordance with the preferred embodiments of the invention, the preamble is only applied to the first data packet to be transmitted to a mobile station in scan mode. Once a preamble has been sent and acknowledged, a preamble will not be added to subsequent data packets destined for that mobile station until the hang-time check timer has expired for that mobile station. This is possible because the acknowledgement will provided the data controller 22 with the necessary channel information to send additional data messages to the mobile station, and because the mobile station will be waiting on that channel for at least a predetermined period of time corresponding to the hang-time check timer.

It will be possible to reduce preamble traffic by further controlling when a preamble message will be sent. For example, a preamble will only be attached to a data message if the identification for the destination mobile station could not be inserted as part of a preamble list in an earlier sent and acknowledged preamble. This is possible because the mobile stations are continuously checking the preamble list. Once a mobile station identifies itself on the preamble list, it remains on the channel in anticipation of receipt of a data message. If the first identified mobile station does not acknowledge the preamble, the mobile identification may be inserted in the next available preamble, or a new preamble for that mobile station may be configured and placed before the first message for that mobile station.

Because it is possible that a mobile station will come onto the channel following the preamble, the mobile station may not be able to determine that it is on the preamble list. With reference to FIG. 7, in another preferred embodiment of the invention, a group of data messages 700 includes a preamble portion 702 that is made up of a plurality of short confirmed message packets 704, each containing the preamble list. Following the preamble is a first data packet 706 intended for the first mobile station identified in the preamble list, a second data

packet 708 intended for a second mobile station on the preamble list and an  $n^{\text{th}}$  data packet 710 intended for the  $n^{\text{th}}$  mobile station on the preamble list. Before the second data packet 708 there is a short confirmed message packet 704 containing the preamble list. Similarly, a packet 704 is inserted before the  $n^{\text{th}}$  data packet 5 710. Thus, a mobile station coming onto the channel after the preamble and during a data packet, will receive the preamble list before the next transmission of a data packet. It will be appreciated that the preamble list contained in the packets 704 may be updated following each transmission of a data packet.

Referring to FIG. 4, a method 300 for providing a priority scan mode of operation is depicted. The method 300 is substantially similar to the method 100 10 illustrated in FIG. 2, and a description of the corresponding operations is not repeated here. Method 300 differs from the method 100 in that the mobile station, upon detecting a data packet at either the scan mode 304 or the wait subscriber's reply time state 314, will suspend priority scan. Also, once the data packet has 15 been processed and an acknowledgment sent if necessary, the mobile station enables priority scan and schedules the next priority scan to occur substantially immediately. This is accomplished in the determine first data packet type state 306, determine data packet type state 312 or subscriber ID first in preamble list state 310. By enabling priority scan immediately after processing and 20 acknowledging a data reception, the likelihood that another data packet will be received before the first priority sample is executed is small. Thus, the mobile station may sample the priority channel and return to the channel on which data reception occurred before a second data packet is sent by the data controller 22.

Referring to FIG. 5, within the data controller 22 a method 400 for 25 coordinating the transmission of data packets to a mobile station in priority scan is shown. From the idle state 402, the data controller 22 determines if the mobile station is in scan mode 404 by checking the scan mode flag. If the mobile station is not in scan mode, the data controller 22 sends the data message, 414. Otherwise, the data controller 22 checks if the mobile station is hanging in non- 30 scan mode, 406. That is, is the mobile station waiting to receive data messages

